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OBSERVATION OF TYPE-III RADIOBURSTS
ON AIS "VENERA-2"

by

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OBSERVATION OF TYPE-III SOLAR RADIOBURSTS

ON AIS "VENERA-2"

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by V. I. Slysh

SUMMARY

Type-III bursts of solar radioemission were observed on the AIS "VENERA-2" in the 985 kc and possibly in the 30 kc/sec frequencies. Estimates have been obtained of electron temperature of the outer corona and of motion velocity of the agent inducing the radioemission.

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As a pursuit of measurements of low frequency radioemission from automatic interplanetary stations (AIS) [1, 2], a measuring receiver, analogous to the one described in [2], was installed on Venera-2 and tuned to the frequencies of 30, 200 and 985 kc/sec. VENERA-2 was launched on 12 November 1965 toward planet Venus. The measurements of low frequency radioemission were conducted uninterruptedly in the course of the first 9 hours of station's flight from the ground, and then readings were taken every 4 hours along the entire trajectory.

Analysis of the telemetered information obtained for about 60 days of flight shows the presence of a rather constant level along all channels. In connection with the excessive threshold response of the 200 kc channel, the constant level had attained within it the upper limit of the measurement scale, thus ruling out the measurement of any kind of variations. Besides the constant level there were observed along the 985 and 30 kc channels a series of ejections of which a part has been easily identified with radiointerferences from the airborne apparatus. Two bursts were observed at 985 kc, and two at 30 kc/sec in the absence of interferences. In order to identify them, comparison was made of the times of burst observations with the data of ground observations on solar radioemission. This was made easier by the comparatively low solar activity during the flight of Venera-2. The comparison disclosed that both bursts at 985 kc corresponded to the type-III radiobursts observed practically simultaneously at the Potsdam Astrophysical Observatory. Reference is made here to the work [3],

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(*) NABLYUDEMIYE SOLNECHNYKH VSPLESKOV RADIOIZLUCHENIYA III TIPA NA AMS "VENERA-2".

according to which the burst maximum in the frequency of 23 Mc was observed on 12 November 1965 at 09 h.05 m.5 U.T. (refer to Fig.1). The estimates of [2] and [4] show that to the frequency of 985 kc/sec corresponds a distance from the Sun of about 10 $R_{\odot}$. For 23 Mc/sec we may take 2 $R_{\odot}$. Hence it is easy to obtain that to the observed lag in the burst, of about 150 sec, corresponds the motion velocity of the agent inducing radioemission, 0.13 c. This velocity value agrees well with the Hartz data [4] at somewhat higher frequency. A close value of velocity is obtained for another type III burst, which took place on 10 December at 1315 hours UT. Apparently, the velocity decrease obtained by Hartz , down to 0.1 c by comparison with the velocity at high frequencies, does indeed take place. As may be seen from Fig.1, the radioburst in the frequency of 985 mc/sec has the shape of a pulse with exponential drop. The magnitude of the pulse decrease by e times approximately in a matter of 150 sec. Following Hartz, one may determine by velocity drop the corona temperature at the place of generation of radioemission, i. e. at R = 10 $R_{\odot}$. For the corona temperature we have [4]

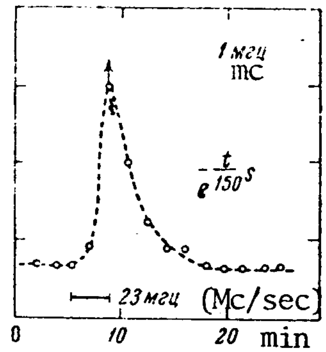

Fig.1. Solar radioburst in the frequency of 985 kc/sec. Shown below are the moments of time of commencement and end of type-III burst at 23 Mc/sec [3]

$$T = 6 \cdot 10^{-5} f^{1/3} (\Delta t)^{2/3} {}^{\circ}K \qquad (1)$$

It is assumed in this formula that the damping of plasma oscillations, which are the source of radioemission, is conditioned by collisions. Substituting $f = 9.85 \cdot 10^5$ and $\Delta t = 150$ into (1). we shall have $T = 1.7 \cdot 10^{5}{}^{\circ}K$. This result confirms also the gradual corona temperature drop from $1.2 \cdot 10^{6}{}^{\circ}K$ at R = 3.8 $R_{\odot}$ to $3 \cdot 10^{5}{}^{\circ}K$ at R = 7.7 $R_{\odot}$, found by Hartz [4]. The maximum value of the burst's radioemission flux constitutes for the case of Fig.1 about 10^{-18} w/m^2/cps. The corresponding flux maximum at 23 Mc/sec was equal to $1.5 \cdot 10^{-19}$w/m^2 cps [3]. The comparison of these quantities points to the rise of the flux as the frequency decreases. On the basis of the available data one may derive the conclusion that the type-III burst had a frequency range of at least 234 – 0.985 Mc/sec. Thus far we spoke only of radiobursts in the frequency of 985 kc/sec. For the reasons indicated above we could not observe bursts in the frequency of 200 kc. However, there remains an interesting possibility that the solar radiobursts may be visible in the lowest frequency of 30 kc/sec. To this frequency corresponds the critical density of 12 electrons/cm^3. Of the same order must be the density in interplanetary-space. Consequently, the Sun's radiobursts may be observed only in the case when the electron density in the vicinity of the AIS is less than 12 electrons/cm^3. As to the possibility of identification of bursts in 30 kc with the corresponding events on the Sun, a great uncertainty arises here, for the identification is carried out by way of comparison of the respective moment of time, while the lag in the frequency of 30 kc/sec may reach high values for two reasons: the great distance of the generation region from the Sun (to 1 a.u. $\sim$ 200 $R_{\odot}$) and the decrease of the group velocity and of scattering on inhomogeneities of the interplanetary medium. Bearing in mind these considerations, let us turn to Fig.2, where we plotted the signal registration at 30 kc/sec during the flight of Venus-2 on 12 November 1965 at geocentric distances from 8 to 25 R_E. The arrow indicates the moment of observation of the burst illustrated in Fig.1. For 0.1 c agent velocity and a distance of 200 R_0 the expected lag is more than one hour. It may be seen from Fig.2

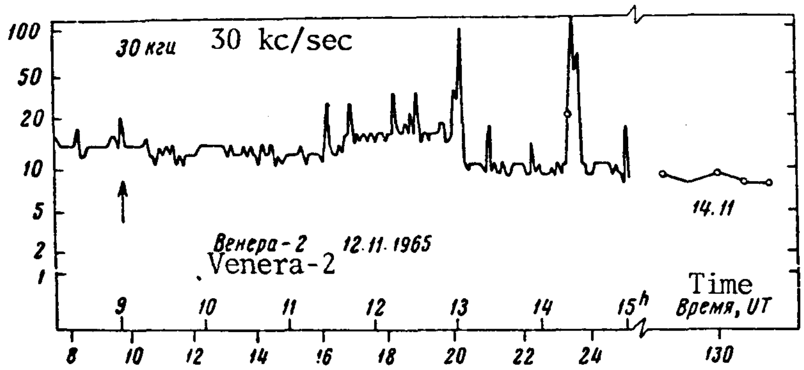

Fig.2. Registration of radioemission power in the frequency of 30 kc/sec during the flight of AIS "VENERA-2" at geocentric distances from 8 to 25 R_E. Five points are shown to the right, which correspond to measurements in interplanetary space at geocentric distances from 120 to 140 R_E. The angle between the directions at the Sun and the AIS is 78°.

that about 3 hours after the burst at 985 kc there is a slanting maximum, and after 5.5 hours there is an isolated ejection. Besides, separate brief bursts are seen. The slanting maximum ended by a shorter burst, following which a level suddenly settled, which was observed in the course of the entire flight in interplanetary space. As a matter of example, we indicated in Fig.2 a few points measured at geocentric distances of 120 – 140 R_E. There exist all the foundations to assume that the slanting maximum is linked with the passage of the region included between the magnetosphere boundary and the shock wave of the magnetosphere, while the great ejection at 20 R_E is linked with the shock wave itself (angle SUN – AIS is 78°). Beyond the shock wave started the interplanetary medium and this is why the large burst near 24 R_E is difficult to ascribe to any event in the Earth's magnetosphere.

There remains a possibility that this burst is the low frequency extension of the type-III burst shown in Fig.1. The duration of this burst is about 300 sec and its shape is similar to that of the burst at 985 kc/sec frequency, and the flux maximum is about 10^{-15} w/cm cps. The lag by 5.5 hours means that for a velocity 0.1 c the agent, inducing radioemission, would have passed 4.4 a.u. At monotonic density drop this flux could not have been observed on the Earth's orbit. Consequently, either the velocity of the agent decreased with the increase of distance from the Sun, at least to 0.015 c, or the group velocity of radiowaves was no more than 0.2 c. To us the first possibility appears to be the most probable. The substitution of $\Delta t = 300$ in formula (1) gives $T = 10^{3}$°K for the electron temperature of the interplanetary medium approximately on the Earth's orbit. It is evident that this quantity must be considered as the lower threshold corresponding to plasma oscillation damping only at the expense of collisions. Evidently, the identification of this burst as a radiobust of the Sun is insufficiently reliable. We may take as a certain corroboration of such an identification the fact that the only other burst at 30 kc was observed 8 hours after the type-III burst in the frequency of 985 kc on 10 December 1965.

THE END

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